FORT BELKNAP BROWNFIELDS PROJECT
PHASE II ESA REPORT

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ASTM	American Society for Testing and Materials
BIA	U.S. Bureau of Indian Affairs
BNA	base/neutral/acid
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COE	U.S. Army Corps of Engineers
EPA	U.S. Environmental Protection Agency
ESA	Environmental Site Assessment
FBEPD	Fort Belknap Environmental Protection Department
FBIC	Fort Belknap Indian Community
FEMA	Federal Emergency Management Agency
FSP	field sampling plan
GPS	global positioning system
HASP	Health and Safety Plan
IDW	investigation derived waste
NRCS	Natural Resources Conservation Service
OAL	Old Agency Landfill
OSHA	U.S. Occupational Safety and Health Administration
PA	preliminary assessment
PCB	polychlorinated biphenyls
PPE	personal protective equipment
PRG	Preliminary Remediation Goals
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
RAS	regular analytical services
REC	Recognized Environmental Conditions
SAP	sampling and analysis plan
SBEMP	Snake Butte Environmental Mitigation Program
SOP	standard operating procedure
SVOC	semivolatile organic compound
VOC	volatile organic compound

EXECUTIVE SUMMARY

Portage Environmental, Inc. (Portage) and teaming partner URS Corporation (URS) were contracted by the Fort Belknap Indian Community (FBIC) to perform a Phase II Environmental Site Assessment (ESA) for the Old Agency Landfill (OAL) and Snake Butte Quarry on the Fort Belknap Indian Reservation. The ESA is part of a three-phase Brownfields Assessment Demonstration Pilot Project that is funded and administered by the United States Environmental Protection Agency (EPA).

The OAL is located at the west side of the town of Fort Belknap Agency, less than a quarter mile south of the Milk River (which forms the northern boundary of the Fort Belknap Indian Reservation). The landfill was used for over 60 years, primarily by federal agencies serving residents on the Fort Belknap Indian Reservation. The landfill accepted residential, agricultural, and industrial wastes (allegedly with materials containing pesticides and polychlorinated biphenyls - PCBs). The landfill closed in the 1960s.

Snake Butte is a historic landmark that has and continues to be used by Tribal members for cultural and religious ceremonies. In the 1930s, the United States Army Corps of Engineers (COE) developed a quarry within a portion of the north side of the butte to supply riprap during construction of the Fort Peck Dam. Large-scale remnants of mining operations that remain at the site include the quarry high wall, several waste rock piles and a railroad grade that extends northward approximately 12 miles from the quarry site to the main rail line near Harlem, Montana.

The Phase II ESA work involved sampling and analysis of surface water, groundwater, and soil to assess the potential presence of contaminants of concern identified in earlier Phase I ESA. The results of the Phase II ESA will then be used for Phase III work that may include a limited risk assessment and/or development of alternatives and costs for proposed corrective actions and future land uses.

A Phase II ESA Work Plan was prepared for OAL and Snake Butte that included a field sampling plan based on conceptual models of potential sources of contamination, possible migration pathways, possible exposure pathways, and receptors of concern. Specific objectives for sampling at the Old Agency Landfill were:

- Define area of landfill wastes.
- Determine adequacy of existing groundwater monitoring wells for contaminant detection.
- Determine presence of pesticide, PCB, VOC, SVOC, and metals soil contaminants in known and suspected source areas.

Specific objectives for sampling at Snake Butte were to:

- Determine the presence of VOC (petroleum hydrocarbon constituents and organic solvents) soil contaminants in suspected spill areas at fuel/chemical storage sites.
- Determine the presence of VOC and nitrate (from blasting agents) groundwater contaminants and measure signature parameters from springs along the base of Snake Butte.

A total of 39 exploratory test pits were excavated at OAL based on reconnaissance using a metal detector and from visual evidence of landfill waste at the land surface (scrap metal, soil staining, distressed vegetation). Based on the results of test pits that indicated the presence of landfill wastes, a total of three surface soil and nine (including one duplicate) subsurface soil samples were collected directly adjacent to test pit locations. In addition to soil samples, a total of seven surface water and groundwater samples were collected for laboratory analyses of inorganic water chemistry parameters to identify the chemical "signatures" of waters present on site. Groundwater elevations and surface water elevations also were measured to determine the likely direction of groundwater flow beneath the landfill.

At Snake Butte, several locations of possible fuel, chemical and explosives storage sites were inspected and, based on visual evidence of staining, a total of two surface soil samples were collected at one location to determine the presence of contamination. This particular area appeared to be the location of a former above ground storage tank based on presence of two small concrete slabs and an obvious black staining adjacent to the slabs and along the roadway, approximately 50 feet from the slabs. A hydrologic reconnaissance of the Snake Butte area was conducted to identify springs that were believed to be representative of groundwater occurring beneath the quarry site. Based on the reconnaissance and topographic map review, a total of three water samples from local springs adjacent to Snake Butte were collected to determine the presence of mining-related contaminants, and for signature parameters to assess the potential interconnection between the springs.

The analytical results of surface and subsurface soil samples at OAL indicate that there is detectable contamination within the landfill boundaries from metals, arsenic and organic chemicals associated with pesticides. There were no VOCs or PCBs detected in soils, and a SVOC was found in one soil sample. Several of the metal constituents (As, Ba, Cd, Cr, Ni, Ag, and Zn) found in soils exceed EPA Soil Screening Levels and one (As) exceeds Region 9 PRGs in multiple samples (refer to Table 4). Although arsenic levels were elevated from the background sample, the reported values are not high relative to naturally occurring arsenic found in many Montana soils.

Detectable levels of pesticides were found in three subsurface soils and three surface soils. The highest concentrations were found in subsurface soils approximately 30 feet from the oxbow pond. This suggests an increased risk of exposure in this area, and potential migration pathway from soils to sediments along the shore of the oxbow pond.

Analyses of groundwater samples collected from the monitoring wells indicate that the water quality beneath the landfill could be impacted from landfill wastes. Specific conductance, sulfate, Al, and Fe appear to be elevated above regional values.

The surface water sample collected from the oxbow pond did not show any impacts to water quality from the landfill. Based on the data from a limited number of surface water samples collected as part of this Phase II ESA and those analyzed in previous reports, there is no evidence indicating that water quality at the Fort Belknap Agency drinking water intake has been affected by the landfill.

Based on surface water and groundwater elevation data, and the detection of elevated inorganic constituents, it also appears that existing OAL monitoring wells are located appropriately in the downgradient groundwater flow direction from waste materials. However, it is uncertain why these wells did not detect pesticide contaminants in groundwater from previous sampling investigations. One reason for this could be that clay in subsurface soil is attenuating the contaminants from landfill waste leachate. However, another possibility is that contaminants from the waste may be migrating as a thin plume within the upper few feet of the water table and above the screened interval of the wells. Water elevation data and construction logs of OAL wells show that the screened intervals of the wells do not begin until six to seven feet below the water table. Therefore, the well completion design may preclude obtaining a fully representative sample of groundwater beneath OAL. To confirm the presence of pesticide contamination in shallow groundwater, two to three monitoring wells could be positioned downgradient of known pesticide waste areas. Such wells should be screened from approximately 5 to 10 feet below the land surface, and groundwater samples obtained for analysis of the pesticide chemicals found in OAL soils.

The analytical results of soil and water samples collected at Snake Butte did not show any indication of VOC contamination, indicating that there are no lasting impacts from these types of constituents from the quarry operations. Although stained soil areas are present in the former quarry site, based on the data collected, there does not appear to be any migration pathway to groundwater or exposure pathway from contact with groundwater for VOC contaminants. Depending on perceived risk to receptors, the areas of stained soil could be resampled and analyzed for other potential contaminants such as SVOCs. However, given the age of the former quarry and stained area, the likelihood of detecting elevated concentrations of organic constituents is believed to be low.

Water samples from the springs also were analyzed for nitrate, a compound commonly found in blasting agents, and those results showed relatively low concentrations. One of the springs did show a detectable level of toluene (a constituent of gasoline). However, the location of the spring relative to the quarry and the lack of any other detectable organic compounds suggests that the source of toluene is not from the quarry.

Based on the Phase II ESA results, there does not appear to be any potential threat to humans or indigenous wildlife in the area from contaminants in waste, soil or groundwater. Any future work performed for Snake Butte, however, should consider a recontouring scheme for the area to promote safety and to better blend the site in with the surrounding, undisturbed topography.

1.0 INTRODUCTION

This Phase II Environmental Site Assessment report was prepared by the Portage Environmental, Inc./URS Corporation (Portage/URS) project team for the Fort Belknap Indian Community (FBIC). The Phase II ESA was conducted as part of a grant awarded to FBIC from the United States Environmental Protection Agency (EPA) to conduct a Brownfields Assessment Demonstration Pilot Project within the Fort Belknap Indian Reservation, North Central Montana (Figure 1). The Fort Belknap Indian Reservation is home to the Gros Ventre and Assiniboine Tribes, and is governed by FBIC Council members.

The FBIC Brownfields Assessment Demonstration Pilot Project is primarily an environmental site assessment (ESA) that is being conducted in three phases for two sites within the reservation. One of these sites is the Old Agency Landfill (OAL) that is located at the west side of the town of Fort Belknap Agency (Figure 1), less than a quarter mile south of the Milk River (which forms the northern boundary of the Fort Belknap Indian Reservation). The landfill was used for over 60 years, primarily by federal agencies serving residents on the Fort Belknap Indian Reservation. The landfill accepted residential, agricultural, and industrial wastes (allegedly with materials containing pesticides and polychlorinated biphenyls - PCBs). The landfill closed in the 1960s.

The second site is Snake Butte, a historic landmark that has and continues to be used by Tribal members for cultural and religious ceremonies. In the 1930s, the United States Army Corps of Engineers (COE) developed a quarry within a portion of the north side of the butte to supply riprap during construction of the Fort Peck Dam. Large-scale remnants of mining operations that remain at the site include the quarry high wall, several waste rock piles and a railroad grade that extends northward approximately 12 miles from the quarry site to the main rail line in Harlem, Montana. Smaller-scale remnants include scrap materials such as sheet metal and wire cables scattered along the ground surface, several small foundations, and underground tunnel openings.

Phase I of the project involved a comprehensive review of available site data, site inspections, and reporting. The purpose of the Phase I ESA was to disclose factual environmental data and information in existence and identify Recognized Environmental Conditions (REC). Phase II ESA work, described in this report, involved sampling and analysis of surface water, groundwater, and soil to further investigate the RECs identified in Phase I work and determine if EPA Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) hazardous substances are present at the two sites (OAL and Snake Butte). Phase III work will then be conducted based on this Phase II report and consultation with Fort Belknap Environmental Protection Department (FBEPD) and EPA, and may include a limited risk assessment and/or development of alternatives and costs for proposed corrective actions and future land uses.

The Phase I, II and III ESA work by the Portage/URS project team at the Old Agency Landfill and Snake Butte sites is being conducted under a FBIC Contract with Portage serving as the prime contractor and URS working under subcontract to Portage. The project was awarded to Portage/URS based on a proposal submitted to FBIC in response to the October 11, 2001 Request for Proposal (FBIC, 2001). The Fort Belknap Brownsfield Assessment Demonstration Pilot Project is being administered locally by FBEPD, with general oversight and federal administration by EPA in Helena, Montana. All ESA work is designed to meet federal requirements for work funded by an EPA Brownfields Grant, and work plans are submitted to EPA and FBEPD for review and approval.

Figure 1. Brownfields Assessment Demonstration Pilot Project Sites

1.1 Purpose

The purpose of the Phase II ESA was to further investigate RECs and potential contaminants of concern identified from the Phase I ESA reports (Portage/URS, 2002a and 2002b). Specifically, Phase II work was to gather data with which to verify the presence of CERCLA hazardous substances that may exceed published limits within primary exposure pathways (soil and water) at the OAL and at Snake Butte.

A Phase II ESA Work Plan (Portage/URS, 2002c) that included a Quality Assurance Project Plan (QAPP), Field Sampling Plan (FSP), and Health and Safety Plan (HASP) was used as the basis for all Phase II ESA activities. The QAPP contains the required information for approval by EPA and follows EPA 540-R-98-038 *Quality Assurance Guidance for Conducting Brownfields Site Assessments*. The FSP includes key components for sampling and data gathering found in American Society for Testing and Materials (ASTM) Designation: E 1903 – 97 *Standard Guide for Environmental Site Assessments: Phase II Environmental Site Assessment Process* as well as in EPA 540-G-89-004 *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*. Combining the QAPP and FSP into the Phase II Work Plan essentially constitutes a SAP as defined by CERCLA guidance. The Work Plan also included a project-specific HASP that follows OSHA 29CFR 1910.120 Hazardous Waste Operations and Emergency Response standards.

The key tasks completed for the Phase II ESA included the following:

- Identify contaminants of potential concern and develop Phase II ESA Work Plan.
- Conduct exploratory test pit excavations to determine approximate boundaries of OAL waste.
- Conduct OAL surface water and groundwater sampling and measure water level elevations to assess groundwater flow directions and suitability of existing monitoring wells for contaminant detection.
- Conduct Snake Butte water sampling and measure elevations of springs to assess hydrogeologic relationship between springs and determine presence of contaminants from historic mine facilities.
- Conduct soil sampling at OAL and Snake Butte to determine presence of contaminants.

Additional detail on the development of these tasks, project organization, and problem definition including descriptions of conceptual models and sampling rationale for OAL and Snake Butte is in the Phase II ESA Work Plan. The Work Plan also includes descriptions of all Standard Operating Procedures (SOPs) for Quality Assurance/Quality Control (QA/QC) and for sampling and handling protocols.

The subsequent sections of this Phase II ESA report describe the activities, results and analyses of data collected from Phase II ESA work. These are presented under the main category headings as follows:

- Background
- Phase II Activities
- Evaluation and Presentation of Results
- Discussion of Findings and Conclusions
- Recommendations
- References and Sources of Information

2.0 BACKGROUND

2.1 Old Agency Landfill

2.1.1 Site Description and Physical Setting

The Old Agency Landfill (OAL) is located on property owned by FBIC at the southwest side of the town of Fort Belknap Agency, in the NE ¼ of the SW ¼ of Section 32, T32N, R23E, Principal Montana Meridian, Blaine County, Montana (Figure 1). Based on visual inspection and test pit excavation, the landfill appears to encompass an area of approximately five acres. The landfill is approximately bounded to the north by an oxbow pond associated with the Milk River, to the east by two ponds constructed for the town's water treatment system, to the south by Tribal Construction offices and equipment storage areas, and to the road that runs parallel to a fenced runway used for small aircraft. The south side of the landfill also contains an elongated pile of apparent demolition waste (concrete and scrap iron) mixed with soil material. The waste pile is oriented approximately northwest-southeast, parallel and northeast of the road, and varies in height and width. Figure 2 is a site map of the landfill that shows key physical features.

A paved road exists from the town of Fort Belknap Agency to the water treatment plant, and the landfill is accessed by an unimproved road extending west of this road. The landfill also has two unimproved vehicle trails within its approximate boundaries. Maxim Technologies, Inc. constructed three monitoring wells (OAL-01, OAL-02 and OAL-03) at the landfill in 2000 as part of a previous site assessment (Maxim, 2000). The landfill is approximately 1,000 feet south of the Milk River, and approximately 0.25 mile upstream of the intake for the community's drinking water system.

The landfill has reportedly not been used since the 1960s. Consequently, the area has a relatively thick vegetative cover consisting primarily of grasses and scattered shrubs. The oxbow pond has an extensive wetland fringe comprised predominantly of cattail.

The OAL is located in a relatively flat area characterized by river alluvial/floodplain and glacial drift deposits overlying older sand, silt and clay of Judith River Formation (Alverson, 1965). A review of the Federal Emergency Management Agency (FEMA) national flood insurance program's flood insurance rate maps for the Fort Belknap Indian Reservation, Montana shows the landfill to be within a 100-year floodplain.

Groundwater immediately beneath the landfill is unconfined and is expressed at the land surface by the water level in the adjacent oxbow pond along the northern border of the landfill. The water table depth varies within the landfill. The water table is approximately seven feet below the land surface within the central portion of the landfill based on water level measurements from the three on-site wells, and gradually decreases in depth towards the oxbow pond to the north. Exploratory test pits excavated between the monitoring wells and oxbow pond encountered groundwater from four to six feet below the land surface along the northern side of the landfill.

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2.1.2 Site History and Summary of Previous Assessments

The OAL was in operation for approximately 60 years before shutting down in the 1960s. The landfill allegedly accepted polychlorinated biphenyls (PCBs) and pesticides in addition to construction and household refuse. This site initially became a concern to FBIC because a sheen was observed by the water intake for the community's potable water plant downstream of the landfill. Other exposure risks are from contact with contaminated soils or inhalation of dust. Many community members also use the area near the site for recreation (hunting, fishing and hiking).

The site was identified in 1988 as part of Region VIII Indian Land Site Discovery Program (EPA, 1989). Ecology and Environment, Inc. completed a preliminary assessment (PA) in January 1990 (Ecology and Environment, 1990) under contract with EPA. The PA noted potential PCB presence in the landfill, with groundwater and surface water as potential exposure pathways. A screening site investigation (medium priority site inspection) was recommended, and Ecology and Environment completed the investigation in July 1990 (Ecology and Environment, 1991) by collecting area soil, sediment, and surface water samples. The July 1990 site visit also noted four 55-gallon drums of poor integrity that had obviously leaked a black oily substance.

The July 1990 investigation collected and analyzed a total of 16 environmental samples (excluding quality control samples). Seven surface water samples were collected consisting of samples from the Milk River (including an upgradient background sample), the adjacent oxbow pond, and the water treatment plant intake pond. Four shallow soil samples (within six inches of the land surface) of the landfill area were collected including a background sample and a sample of potentially concentrated waste in the area of the four 55-gallon drums. Four Milk River sediment samples were collected including a background sample, and one sediment sample was collected from the shore of the oxbow pond. All samples were analyzed for volatile organics, base/neutral/acid (BNA) extractable organics, pesticide/PCB, and regular analytical services (RAS) inorganics. Key analytical findings were as follows:

- The water sample from the water treatment plant pond contained elevated copper (Cu), manganese (Mn) and sodium (Na). The plant uses copper sulfate in the pretreatment pond to control algae.
- Toluene was detected in sediment and soil samples, including the background soil sample.
- The oxbow sediment sample contained elevated aluminum (Al), barium (Ba), chromium (Cr), iron (Fe), lead (Pb), manganese (Mn), nickel (Ni), potassium (K), vanadium (V), and Zinc (Zn).
- The soil sample from the drum spill area contained chrysene and elevated Al, Pb, V, and Zn.
- The water sample from the oxbow pond contained elevated magnesium (Mg) and K.
- Pb was detected at elevated concentrations in the oxbow sediment sample, an on-site soil sample, and in Milk River sediment samples.

Based on these analytical findings, the Ecology and Environmental (1991) concluded that Pb and toluene were "observed releases" in sediments of the Milk River downstream of the probable point of entry of landfill-related waste. Toluene and chrysene also were found in "large concentrations" in on-site surface soils. The two on-site wastes sources identified by the investigation consisted of the soils in the drum area, and generalized on-site surface soil contamination. An internal EPA memorandum (March 20, 1991 memo from Steve Yarbrough to Ron Bertram) however suggested "…the frequent documentation of toluene as a lab contaminant makes usage of this contaminant at least somewhat questionable."

Upon completion of the screening site investigation, EPA determined that the landfill did not have the potential to score high enough for consideration as a National Priority List (NPL) site under CERCLA based on the small quantity of wastes and the relatively few targets. The site was declared "No Further Remedial Action", and FBIC became the lead agency for the site. This designation does not preclude EPA's Emergency Response Branch from taking action at the facility if necessary.

In 1999, FBIC received a Clean Water Act Section 106 Special Programs Grant from EPA to conduct a final assessment of OAL. The objective of the final assessment was to determine impacts to surface water and groundwater from the landfill. During the course of the final assessment, Maxim Technologies, Inc. constructed three shallow (less than 20-feet deep) groundwater-monitoring wells at the landfill, and collected surface water (oxbow pond) and groundwater samples (from the new wells) for analyses of metals and organic constituents including pesticides and PCB. The results of this work (Maxim, 2000), and subsequent sampling by FBEPD personnel, showed that groundwater within the area of the landfill contains detectable concentrations of metals (with apparently elevated levels of sulfate and iron), but there were no detectable levels of organic chemical contaminants. Maxim attributed the elevated sulfate concentrations to the high sulfate content of the Judith River Formation underlying the site.

Assisted by FBEPD personnel, Portage and URS conducted a Phase I ESA of OAL in the spring of 2002 (Portage/URS, 2002a). The Phase I work noted that the landfill is still being used for construction/demolition waste. Large concrete manhole vaults were observed as well as freshly dumped soil. Older construction demolition waste also was observed near the northeastern edge. A patch of tar-like substance (approximately 15-feet by 4-feet) was observed approximately twenty feet south of the oxbow lake. Based on the site sample location map by Ecology and Environmental (1991), this area does not coincide with the location of the four drums that were observed to be leaking a black oily substance.

Key individuals at Fort Belknap with historic site knowledge were interviewed and shown aerial photos from 1956 and 1997. Some interviewees, when presented with the aerial photos, remember the OAL as existing in a different area, suggesting the landfill was further east than the area previously investigated. However, one source that worked for the Indian Health Service for many years, recalls the landfill as being located within the project area, but oriented along the oxbow lake.

The Phase I interviews also indicated that the sedimentation and backwash evaporation ponds for the water treatment plant were constructed approximately 30 years ago, and lined with bentonite clay. The edges of the ponds are sprayed with copper sulfate to minimize weed/algae growth, and the plant uses Liquid Alum (aluminum sulfate) as a coagulant in the water treatment process. Water from the backwash evaporation pond is frequently discharged into the oxbow lake.

Key findings from the Phase I ESA used as the basis for the Phase II work are as follows:

- Records reviewed indicate that OAL collected agricultural and residential wastes, potentially including pesticide and PCB wastes, for approximately 60 years. Interviewees reported the heavy use of pesticides in the area, particularly mosquito suppression in and around the oxbow pond and river. Although PCBs and pesticides are not REC's, past reports indicated their possible presence. Analytical testing in the past was relegated to surface water, shallow ground water, and shallow soil (within six inches below the land surface). There had been no sampling of soil deeper than six inches.

- Sampling results from the final screening site assessment conducted by Ecology and Environment indicate the presence of toluene, chrysene, lead, aluminum, vanadium and zinc in elevated concentrations in surface soils; elevated toluene and lead were noted in the Milk River sediments; and elevated copper was noted in the surface water samples. The screening site assessment also noted four overturned and leaking 55-gallon drums.
- Interviews with key individuals indicate that the actual landfill location may extend beyond the boundaries reported in prior studies. Some interviewees indicate that the landfill may extend up to 250 feet west of the site. One reliable source indicated that the landfill is oriented parallel to the oxbow lake. This was pointed out on a 1956 aerial photograph.
- Further site characterization and environmental sampling of OAL is warranted.

2.1.3 Adjacent Property Land Use

The Old Agency Landfill is located in an industrial part of the community on property owned by FBIC. Neighboring properties include:

- Bureau of Indian Affairs (BIA) maintenance and storage facilities located east, beyond the water treatment plant. These facilities are used for vehicle maintenance (ranging from motor vehicles to heavy equipment), above ground fuel storage, road maintenance supply storage, range supplies storage, and reportedly to store chemicals in buildings on the premises.
- Tribal Construction offices and storage facility are located to the southeast. Construction materials and Tribal vehicles and equipment are stored on the site.
- Community water system treatment plant and its two associated treatment ponds border the northeast side of the landfill.
- A runway used for small aircraft that borders the landfill to the southwest.

2.2 Snake Butte

2.2.1 Site Description and Physical Setting

Snake Butte is a prominent geological landform located six and one-half miles southwest of the town of Fort Belknap Agency in the S ½ of Section 35, T31N, R22E, Principal Montana Meridian, Blaine County, Montana (Figure 1). Snake Butte measures approximately 2.5 miles long by 1 mile wide and rises over 200 feet above the surrounding plains at an elevation exceeding 3,100 feet above sea level. Snake Butte is surrounded on all sides by open land controlled by FBIC.

The area of concern to FBIC is a portion of Snake Butte that was mined by the U.S. Army Corps of Engineers (COE) in the 1930s to provide rock used as part of the Fort Peck Dam construction. The quarry site is approximately 0.75 miles long and encompasses approximately 65 acres on the north side of Snake Butte (Figure 1). A 12-mile long railroad line also was constructed as part of quarry operations to transport the rock from the quarry to the main rail line near Harlem, Montana (northern boundary of the reservation). The railroad crossed several surface drainage features, the largest at Three Mile Coulee (FBEPP, 1999).

Quarry operations physically modified Snake Butte by creating a high wall, waste rock piles, roads, and the railroad grade. The quarry and railroad line were abandoned in the late 1930s, but these physical changes to the land surface remain. The mining operation also created a large network of underground tunnels used for placement of explosives for blasting the rock. Most of these tunnels are assumed to have been destroyed during blasting operations, but several tunnel openings still exist at the site. These openings are now partially collapsed and are no longer safely accessible. Portions of the quarry site still contain small amounts of scattered metal debris consisting of cables, sheet metal, nuts and bolts, and steel cans/buckets. There are no other obvious signs of waste materials at the site, although it is possible that some of the waste associated with the operations was buried beneath waste rock and soil at the close of mining operations. The vegetation at the quarry site is sparse and typical of disturbed soil vegetation.

There are six miles of gravel road that provide access to Snake Butte from State Highway 66. Numerous trails provide access to the quarry and other areas within Snake Butte. Access to the railroad grade is possible by vehicles, but is mainly off-road. In general, Snake Butte and the railroad grade are accessible during dry conditions where roads or trails have been established. However, Snake Butte itself is an area of high topographic relief, and portions of the landform are not accessible by vehicle.

In geologic terms, Snake Butte is a lacolith (lenticular-shaped intrusive body) consisting of shonkonite rock (Leppert, 1985). Rapid cooling of the intrusive body created dramatic columnar jointing along the undisturbed margins of the formation. This jointing is less pronounced where mining activities where conducted. Glacial deposits blanket the area surrounding Snake Butte over shale and sandstone of the Judith River Formation (Alverson, 1965).

Surface water within the area of Snake Butte and the railroad grade is characterized by ephemeral drainage features that collect and convey precipitation runoff. Snake Butte is drained by Three Mile and White Bear creeks, which drain into the Milk River in the northeastern part of the Fort Belknap Indian Reservation. Groundwater occurs locally within the extensive fracture system of Snake Butte by precipitation recharge over the butte that becomes perched on less permeable shale that has been "baked" when the intrusive body was emplaced (Alverson, 1965). Three springs along the base of the butte were identified from the Phase I ESA. Two of these occur on the north face of Snake Butte and have been developed (improved) to provide sources of water. The third spring occurs at the base of the east face of the butte and provides water to the resident buffalo herd (FBEPP, 1999). These springs are discussed further in Section 4.2.1 of this report.

2.2.2 Site History and Summary of Previous Assessments

The COE mined a portion of the north side of Snake Butte in the 1930s to provide rock used as part of the Fort Peck Dam construction. Mining-related activities at the site occurred from approximately 1934 though 1939 and included drilling, blasting, and loading boulder-sized material using mechanized equipment onto railroad cars for rail transport. Related infrastructure at the site included buildings/sheds, roads, electrical lines, and various stationary and mobile equipment that operated by electricity, fuel oil and gasoline.

Figure 3 shows the general physical features of the quarry site. A review of historical photographs taken during the time of quarry operations indicates that the site consisted of two distinct areas that included the quarry itself where most of the rock was mined, and a maintenance yard where the rail cars were loaded and maintenance facilities were located. The maintenance yard was located adjacent to but lower in elevation from the quarry.

Snake Butte has historically been, and remains, a culturally significant site and is still used by FBIC tribal members for religious ceremonies. The Phase I ESA investigation by Portage/URS also found that rock from Snake Butte is still taken for use as riprap on small construction projects and for memorials.

A preliminary investigation of Snake Butte and the associated railroad grade was conducted in April 1999 by the Fort Belknap Environment Department's Snake Butte Environmental Mitigation Program (SBEMP). The investigation team consisted of personnel from SBEMP, Bureau of Indian Affairs (BIA), Natural Resource Conservation Service (NRCS), and FBIC Council members. This investigation focused on physical and cultural aspects of Snake Butte and was primarily concerned with impacts associated with the railroad grade (FBEPP, 1999). Although the results emphasized the disruption of natural hydrologic flow caused by the railroad grade, team members also identified other concerns including ground settling/subsidence and safety issues within the quarry site. A team member also suggested that the north spring (drinking water spring) should be tested for potential hydrocarbon contamination due to historic use of fuel oil/gasoline at the quarry.

With assistance by FBEPD personnel, Portage/URS conducted a Phase I ESA of Snake Butte in the spring of 2002. The Phase I ESA results (Portage/URS, 2002b) based on review of historic photographs suggest that fuel and explosives storage areas were present at Snake Butte during historic mining operations, and that waste oil and chemicals (solvents) were probably used/stored in the maintenance area. However, the Phase I ESA did not find any documentation of previous environmental investigations at Snake Butte (other than the FBEPP 1999 report). Therefore, there was no definitive information available to confirm or deny the potential presence or distribution of contaminants.

Although there is no previous documentation of environmental impacts at Snake Butte, the Phase I ESA did note the following items on or adjacent to the former maintenance yard located on the north side of Snake Butte, suggesting that contaminant sources could be present at the site:

- Based on historical photos, an above ground storage tank was located in the former maintenance yard. The concrete foundations for the tank are still in place. The contents of the former tank are unknown. However, based on the identification of diesel equipment in the historical photos, the tank may have potentially contained diesel or fuel oil. A 2-foot by 20-foot area of a black substance was noted on an east-facing slope below this area during the site inspection.
- On the northeast side of the former maintenance yard, rubbish appeared to be thrown into a gully. This rubbish included one 5-gallon empty unlabeled metal bucket, one empty one-gallon can of antifreeze, one half-barrel with handles on the sides, and other small containers

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of unknown origin. No surface soil staining or other evidence of contamination was noted near this area.

- A small amount of rusted metal scrap was found in the former maintenance area. This included metal pipes, cable, and tin from buildings.
- One 55-gallon drum was identified in the gully on the northeast side of the former maintenance yard. The drum was rusted, not labeled and empty. No surface soil staining or other evidence of contamination was noted near this area.
- A 5-foot by 20-foot by 5-foot deep concrete foundation was noted on the west side of the former maintenance yard. The foundation has a concrete floor that is covered by approximately 6 inches to 2 feet of windblown soil.

FBEPD personnel indicated to Portage/URS that there was a relatively recent detection of coliform bacteria at the north spring (drinking water spring) from a sample collected by Indian Health Services personnel. This implies that water resources at the site could be vulnerable to near-surface sources of contamination. If present, near-surface sources of contaminants from historic mining operations at the quarry site also could be impacting water resources in the area.

In addition to the quarry site, the Phase I ESA inspection included the entire route of the 12-mile long railroad grade. Although there were remnants of wood railroad ties and bridge pilings observed at several locations, there was no obvious evidence of contamination in these or any other areas along the grade.

2.2.3 Adjacent Property Land Use

The general area around Snake Butte is used by the public for hunting, hiking and wildlife viewing. Area ranchers also use the adjoining area for rangeland and as winter-feeding ground for cattle. The area directly adjoining Snake Butte is essentially open land, with pasture-type land on the east, south and west sides of the butte that is home to a buffalo herd managed by FBIC. This area was also used for the reintroduction of the Black Footed Ferret in 1996. There are no residences in close proximity to Snake Butte. However, there is a surface water reservoir on the north side of Snake Butte that is used by the public for recreation (fishing and picnicking).

3.0 PHASE II ACTIVITIES

The principal objective of Phase II ESA field sampling was to gather sufficient data with which to verify the presence of CERCLA hazardous substances that could exceed published limits within primary exposure pathways (soil and water) at the Old Agency Landfill and Snake Butte. In turn, this information will be used to develop an appropriate Phase III strategy.

The field portion of the investigation was completed in two separate visits to the Fort Belknap Indian Reservation. The first occurred during the week of September 23, 2002 and consisted of test pit excavation at OAL, and surface water and groundwater sampling at OAL and Snake Butte. The second occurred during the week of October 21, 2002 and consisted of additional test pit excavation at OAL, soil sampling at OAL, and soil sampling at Snake Butte.

Phase II ESA activities followed the FSP and are based on the conceptual model of the OAL and Snake Butte sites developed from the Phase I ESA work. The only deviation from the FSP is that duplicate and field blank samples for water or groundwater samples were not collected. The scope of the assessment and methodologies used for Phase II activities are described in the sections below. Further details on the scope of assessment are in the Phase II ESA Work Plan (Portage/URS, 2002c).

3.1 Scope of Assessment

3.1.1 Record Review

The scope of the Phase II ESA included review of previous analytical results of soil and water samples collected at OAL, historical documents and photographs on file with FBEPD for Snake Butte, and other literature describing geological and hydrological conditions on the Fort Belknap Indian Reservation. These materials are referenced in the Phase I reports for OAL and Snake Butte (Portage/URS, 2002a and 2002b) and, as appropriate, in this Phase II ESA report.

3.1.2 Conceptual Site Model and Sampling Plan

Old Agency Landfill

The Old Agency Landfill site conceptual model (Portage/URS, 2002c) includes:

Potential Sources of Contamination: The source of contamination is landfilled waste.

Possible Migration Pathways:

- Landfilled waste to soils: Contaminants found in landfilled waste may migrate to surrounding soils.
- Contaminated soils to groundwater: Contaminants may migrate from contaminated soils to groundwater.
- Contaminated groundwater to surface water and sediments: Contaminants may migrate downgradient from contaminated groundwater to nearby surface water (Milk River) and sediments.

Possible Exposure Pathways:

- Direct contact to landfilled waste, contaminated soils, contaminated groundwater, contaminated surface water, or contaminated sediments. Human direct contact would most likely occur during construction activities near the landfill or during recreational use of contaminated areas. Ecological direct contact would most likely occur with indigenous species.
- Ingestion of contaminated soils, groundwater, surface waters, or sediments. Ingestion of contaminants would most likely occur either during recreational use of the area or by residential ingestion of contaminated drinking water. Ecological ingestion would most likely occur with indigenous species.

Receptors of Concern: For the residential scenario, humans may be exposed to contaminants through direct exposure to soils or by ingestion of contaminants by drinking water collected through the water intake downstream of the site. For the recreational scenario, humans may be exposed to contaminants through direct contact with contaminated surface soils. For the ecological scenario, waterfowl and aquatic life could be exposed to site contamination from pollutants transported via surface water and found within sediments. Additionally, construction workers may be exposed to contaminants by contact with both surface and subsurface soils.

From this conceptual model, a sampling plan for OAL was designed to verify the presence or absence of contaminants in soils. Previous sampling detected limited contamination in surface soils and sediment, but did not confirm contamination of landfill wastes in subsurface soil (no subsurface samples collected), surface water or groundwater. As suggested by a 1990 PA (Ecology and Environment, 1990), the relative immobility of PCBs and other organic chemicals when in contact with clayey materials, may be the reason that these constituents were not detected in water samples. If this condition exists, it implies that there could still be contamination in subsurface soils that could create a potential hazard to human health and the environment.

More importantly, the landfill boundaries and area of landfill wastes have never been accurately determined. This raises the question as to whether the landfill groundwater monitoring wells are adequately located to enable detection of contamination from landfill leachate. Although groundwater monitoring has not shown detectable levels of organic chemical contaminants, groundwater samples within the area of the landfill do show detectable concentrations of metals (with apparent elevated levels of sulfate and iron). Of interest is the variability of some groundwater quality parameters (e.g. pH, specific conductance and sulfate) over relatively short distances. This would imply that waste materials within the landfill could be impacting water quality on a very localized scale. Alternatively, the presence of the water treatment settling/backwash ponds adjacent to the landfill also could be impacting water quality. The Phase I ESA discovered that copper sulfate and aluminum sulfate are applied to the water in the ponds for weed control and as a coagulant, respectively. If the water quality in the landfill area is affected by the settling/backwash ponds, it also is conceivable that leakage from the ponds may be affecting the groundwater flow direction such that the landfill monitoring wells are not in the downgradient path of landfill leachate.

Therefore, the preliminary objectives at the OAL were to better define the landfill boundaries and to verify that the existing monitoring wells are capable of detecting contaminated leachate from landfill waste. Once the boundaries are confirmed, and assuming the monitoring wells were properly located, the remaining tasks of the Phase II ESA investigation are to verify the presence or absence of pesticides, PCBs, VOCs, SVOCs, and metals within the soil matrix at depth and the presence or absence of pesticides, PCBs, SVOCs, and metals in surface soils.

Specific objectives for sampling at the Old Agency Landfill are:

- Define area of landfill wastes.
- Determine adequacy of existing groundwater monitoring wells for contaminant detection.
- Determine presence of pesticide, PCB, VOC, SVOC, and metals soil contaminants in known and suspected source areas.

The sampling design involved three main steps. The first was to delineate the extent of landfilled waste based on exploratory test pit excavations. The second was to determine groundwater flow direction by measuring water levels and sampling for signature parameters to determine the chemical relationship between groundwater wells and area surface water features. The third was based on the first step, and involved sampling subsurface and surface soils for potential contamination. A potential fourth step, contingent upon findings of the soil sampling, would be to sample the oxbow pond and/or Milk River sediments adjacent to and downstream from the site for potential contamination (discussed in Section 5.1 of this report).

<u>Snake Butte</u>

The Snake Butte site conceptual model (Portage/URS, 2002c) includes:

Potential Sources of Contamination: The source of contamination is waste materials spilled during site operation.

Possible Migration Pathways:

- Waste material to soils: Contaminants found in original waste materials may migrate to soils through spills.
- Contaminated soils to groundwater and surface water: Contaminants may migrate from contaminated soils to groundwater. Groundwater in the area may discharge to surface via springs in the area.

Possible Exposure Pathways:

- Direct contact with original waste materials, contaminated soils, contaminated groundwater or contaminated surface water. Human direct contact would most likely occur during construction activities or during recreational use of contaminated areas. Ecological direct contact would most likely occur with indigenous species.
- Ingestion of contaminated soils, contaminated groundwater or contaminated surface waters. Ingestion of contaminants would most likely occur either during recreational use of the area or by residential ingestion of contaminated spring water. Ecological ingestion would most likely occur with indigenous species.

Receptors of Concern: Receptors of concern are human and indigenous wildlife.

The Phase I ESA results and historic photographs suggest that fuel and explosives (and probably waste oil and solvents) storage areas were present at Snake Butte during historic mining operations. However, there is no definitive information available to confirm or deny the presence or potential distribution of contaminants at Snake Butte. Since there is little visual evidence to clearly indicate the location of potential contamination associated with past mining and equipment operations/maintenance, soil sampling at Snake Butte was limited to areas where surface spills were suspected.

There are no wells near the Snake Butte quarry site available to use for collecting groundwater samples. Therefore, potential impacts to area groundwater were determined by collecting water samples from three springs that occur at the base of the butte near the quarry. In addition to suspected quarry-related contaminants, the water samples were analyzed for signature parameters to assess whether the springs are hydrologically connected, and therefore representative of regional groundwater.

Specific objectives for sampling at Snake Butte were to:

- Determine the presence of VOC (petroleum hydrocarbon constituents and organic solvents) soil contaminants in suspected spill areas at fuel/chemical waste storage sites.
- Determine the presence of VOC and nitrate (from blasting agents) groundwater contaminants and measure signature parameters from springs along base of Snake Butte.

3.1.3 Chemical Testing Plan

The chemical analytes for OAL and Snake Butte samples include contaminants of potential concern and signature parameters for water. The parameters for each site and for each media are as follows:

Old Agency Landfill

Surface Soil: Polychlorinated biphenyls (PCBs), Pesticides, semi-volatile organic compounds (SVOCs), silver (Ag), aluminum (Al), arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), nickel (Ni), lead (Pb), selenium (Se), thallium (Tl), vanadium (V), zinc (Zn)

Subsurface Soil: PCBs, Pesticides, volatile organic chemicals (VOCs), SVOCs, Ag, Al, As, Ba, Cd, Cr, Cu, Hg, Ni, Pb, Se, Tl, V, Zn

Groundwater and Surface Water: Al, Cu, Fe, sodium (Na), chloride (Cl), sulphate (SO_4), field specific conductance, field pH

VOCs were not anticipated to be present in surface soils given the age of the landfill and the likelihood that these constituents would have volatilized to below detectable levels due to atmospheric exposure. Therefore, they were not included in the analyte list for surface soil samples.

Snake Butte

Surface soil: VOCs (indicative of petroleum hydrocarbons and solvents)

Water (Springs): VOCs, iron (Fe), manganese (Mn), calcium (Ca), magnesium (Mg), Na, Cl, SO_4, Alkalinity Forms (total, carbonate, bicarbonate, and hydroxide), nitrate plus nitrite as nitrogen (NO_3+NO_2 as N), field specific conductance, field pH

3.1.4 Field Explorations and Methods

Field explorations for Phase II ESA activities tiered off of the initial Phase I ESA interviews and site inspections and included additional field reconnaissance and test pit excavation to identify subsurface waste materials. This was particularly important for OAL because the actual landfill boundaries were uncertain. This was less important for Snake Butte inasmuch as the presence of rock (boulders) precluded test pit work. The specific types of field explorations and methods for each site are described below.

Old Agency Landfill

Geophysical Reconnaissance: A geophysical reconnaissance was conducted to determine optimal sites for exploratory test pits to define approximate landfill boundaries. The reconnaissance consisted of sweeping the suspected landfill area with a hand-held Schonstadt Model MAC 51 metal detector. The locations that provided strong signals were flagged and later excavated to verify the presence of landfill waste materials.

Test Pit Excavation: A total of 39 exploratory test pits were excavated based on the reconnaissance using the metal detector and from visual evidence of landfill waste at the land surface (scrap metal, soil staining, distressed vegetation). Figure 2 shows the test pit locations.

The test pits were excavated using a John Deer Model 580L backhoe with an extendable hoe capable of reaching depths up to 15 feet below the ground surface. The pits were excavated by first removing and segregating the upper 12-inches of soil cover and placing this material to one side of the excavation, then excavating down to landfill waste (if present) and placing this material to the other side of the excavation. Typical test pits were 2-feet wide by 10-feet long by 8-ft deep. Pits that encountered waste were generally shallower (less than 6-feet) and pits that did not encounter waste were generally deeper (up to 10 feet deep). Once the pits were excavated and the materials documented, the excavations were backfilled following the sequence of material removal, placing the topsoil last. Table 1 summarizes the findings of each exploratory test pit.

Table 1. OAL Exploration Test Pit Summary

ID	Depth (ft below surface)	Groundwater Depth (ft below surface)	Waste Type	Comments
OAL-TP-01	9	5	None encountered	
OAL-TP-02	8	4	None encountered	Heavy clay soils/glacial till, moist w/black organic inclusions.
OAL-TP-03	7.5	6	None encountered	
OAL-TP-04	4.5	4	Tar-like substance at surface 4”-6” thick. Wire, bottles, metal scrap, wood debris beneath tar.	Area of tar-like substance covering surface.
OAL-TP-05	5	5	None encountered	
OAL-TP-06	4.5	None encountered	Bricks, some wood debris mostly within upper 1.5’	
OAL-TP-07	6	None encountered	None encountered	
OAL-TP-08	7	None encountered	Few bricks near surface.	
OAL-TP-09	4	None encountered	Glass bottles, metal cans, bones, metal debris.	Waste-soil interface dips toward the pond.
OAL-TP-10	6	4.5	None encountered	
OAL-TP-11	6	None encountered	Bricks at depth of 2’ – no waste below. Appears to be undisturbed ground with overlying fill.	
OAL-TP-12	6	None encountered	Metal detector found traces of metal, mostly an old fence and some surface liter.	
OAL-TP-13	7	None encountered	Metal, glass, and wood waste at a depth of 5’, Waste present to total pit depth of 7’.	

OAL-TP-14	5	5	None encountered	Checked area to the W and SW of the oxbow pond. Found no visual evidence of waste and only traces of metal detected with the metal detector.
OAL-TP-15	7.5	None encountered	None encountered	Moisture increases with depth, very plastic clay.
OAL-TP-16	7.5	None encountered	None encountered	Moisture increases with depth, very plastic clay.
OAL-TP-17	8	None encountered	None encountered	Glacial till and sandstone.
OAL-TP-18	8	None encountered	None encountered	Hard glacial till, moisture increases with depth.
OAL-TP-19	10	None encountered	None encountered	Stiff glacial till
OAL-TP-20	9	None encountered	None encountered	Stiff glacial till
OAL-TP-21	9	None encountered	None encountered	
OAL-TP-22	8	None encountered	Waste within upper 12”, mostly metal scrap, with plastic sheeting and one glass vial. No waste at depth.	
OAL-TP-23	5	None encountered	Buried metal scrap/appliances (refrigerators). Appear to be at the east edge of waste; no waste on the east end of trench.	
OAL-TP-24	5.5	None encountered	None encountered	Medium stiff clay with rounded gravels.
OAL-TP-25	5.5	None encountered	None encountered	Moist clay
OAL-TP-26	6.5	None encountered	None encountered	Likely fill soil overlying glacial till.
OAL-TP-27	6.5	None encountered	Very corroded metal at 4’, some fiberglass insulation.	
OAL-TP-28	4	None encountered	Metal scraps, bedsprings, cardboard, rubber, glass.	SW end of trench has no waste
OAL-TP-29	8	None encountered	Household waste (cans, bottles, plastic, bones, ash, and cable).	Appears to be south edge of waste trench – no waste on south end of test pit.
OAL-TP-30	4	None encountered	Similar to TP-28 and TP-29.	Waste at NE end of trench.
OAL-TP-31	5	None encountered	None encountered	
OAL-TP-32	3	None encountered	Metal, ashes, burned (melted) glass bottles, wheel rim.	
OAL-TP-33	2	N/A	Metal scrap (household appliances) just under surface.	
OAL-TP-34	5	None encountered	None encountered	Clay/glacial till with rounded cobbles. Area south of road and runway.
OAL-TP-35	5	None encountered	Bricks from 0”-24” overlying native soil/glacial till.	Area south of road and runway.
OAL-TP-36	4	None encountered	Bricks from 0”-12” overlying native soil/glacial till.	Area south of road and runway.
OAL-TP-37	4	None encountered	Bricks and metal scrap from 0”-12” overlying gravely fill.	Loose/gravely fill material.
OAL-TP-38	6	None encountered	None encountered	Loose/gravely fill material.
OAL-TP-39	7	None encountered	None encountered	Clayey glacial till with red and black staining. Pit excavated below base of large rubble pile, west side of landfill.

GPS Survey: All test pit locations and other key area landmarks (roads, fences, etc.) were surveyed by FBEPD personnel using Global Positioning Survey (GPS) equipment. The survey data were then used to develop a digital map of the site (Figure 2).

Water Sampling and Field Parameter Measurement: Surface water and groundwater samples were collected for laboratory analyses of inorganic water chemistry parameters and for measurement of field parameters to identify the chemical "signatures" of waters present on site. The elevations of surface water bodies and groundwater levels in the three on-site wells also were surveyed using standard survey equipment to develop a potentiometric map of the site. The groundwater elevations were determined by measuring the depth to groundwater from the top of the well casing, then surveying the tops of the casing relative to a common datum. Both water chemistry and water elevation data were obtained to evaluate the hydrologic connection between surface water and groundwater, and the potential influence of the water treatment settling/backwash ponds on groundwater flow directions. In turn, this information was used to verify that the monitoring wells previously constructed at OAL are capable of detecting contaminants from upgradient landfill sources.

Prior to collecting groundwater samples from the three on-site wells, each well was first purged using the FBEPD's portable peristaltic pump. Two of the wells were pumped completely dry, then allowed to partly refill before the sample was collected with the same pump used for purging. The third well did not pump dry, so the purge volume (greater than three well volumes; see Appendix 1) was determined by pumping the discharge into a 5-gallon pail, then monitoring pH and specific conductivity in the pail using a hand-held Oakton Model 88012 pH, conductivity and temperature meter. A groundwater sample was collected for laboratory analysis when pH and specific conductivity values stabilized. All samples collected for metals analyses were filtered using a 0.45 micron cartridge filter attached to the pump's discharge line.

Surface water samples were collected as grab samples by submerging the sample bottles for laboratory analysis directly into the water body. Field pH, specific conductivity and temperature were measured by lowering the sensor from the Oakton meter directly into the water body.

Snake Butte

Site Reconnaissance: A hydrologic reconnaissance was conducted at Snake Butte to assess the potential migration pathways of soil contaminants to the underlying groundwater system and nearby springs. The reconnaissance consisted of touring the perimeter and interior of Snake Butte by vehicle, observing area topography, and identifying springs that were likely to be surficial expressions of groundwater from the quarry area.

A surface soils reconnaissance also was conducted within the quarry site to look for evidence of contaminants in the four waste areas identified in the Phase I ESA report. A subsurface soils investigation was thought to be impractical at Snake Butte due to the relatively large area involved, and since any buried waste was likely to be covered over with boulders/waste rock. Therefore, the reconnaissance focused on surface soils by walking suspected contaminant areas and making shallow excavations using a hand shovel in locations of apparent soil staining.

Water Sampling and Field Parameter Measurement: Water samples were collected from three springs that occur at the base of Snake Butte to determine the presence of contamination and to evaluate the hydrologic connection between springs by comparing the chemical signature of each spring. These springs were first identified in the Phase I ESA and, based on the hydrologic reconnaissance, appear to have the greatest potential of being impacted by historic mining operations at the quarry. The elevation of each spring also was measured by FBEPD personnel using GPS to help assess the likely direction of groundwater flow relative to the springs and quarry site.

The spring samples were collected for laboratory analyses as grab samples by either acquiring the sample directly from a discharge pipe, submerging the sample bottle into standing water, or by first collecting a sample using a 5-gallon bucket and filling the sample bottles directly from the bucket. Field pH, specific conductivity and temperature were measured using the portable Oakton meter.

3.1.5 Field Documentation

Field activity documentation included field forms (Appendix 1), field logbook (Appendix 2) and site photographs (Appendix 3). Field forms provided sample-specific documentation and descriptive detail on sample collection. Field forms were completed for each soil and water sample collected at OAL and Snake Butte.

Field logbooks were kept for all test pit, soil and water sampling activity. The logbooks provide a written record for all field data gathered, field observations and samples collected for laboratory analysis. They also ensure that field activities are properly documented and that site work was conducted in accordance with the Phase II ESA Work Plan.

Selected test pits and all soil sampling points at OAL were documented using digital photographs to provide a visual record of stratigraphy and type of waste material present. All photographs were noted in the field logbook or on a field form.

3.1.6 Management of Investigation Derived Waste

Investigation derived waste (IDW) was managed according to the procedures described in the Phase II ESA Work Plan. Examples of investigation derived waste include decontamination fluids, personal protective equipment (PPE), and disposable sampling equipment. No RCRA regulated solvents or materials were used.

Soil excavated from test pits at OAL was backfilled with compaction and graded to promote positive drainage away from the test pit. Topsoil was segregated during excavation and replaced as the surface soil layer. This return of existing material is not considered land disposal since material will be returned to the original area of concern without transferring to a separate unit.

Prior to decontaminating the backhoe bucket used for soil sampling, all soil material adhering to the bucket and/or backhoe boom was scraped off and returned to the original excavation. Decontamination water was allowed to drain off of the equipment above the most recently excavated test pit prior to completing backfill of the uppermost 1-2 feet of soil.

PPE and disposable sampling equipment was disposed of as municipal solid waste. Hand tools used for soil sampling were decontaminated with soap (Alconex) and water, and rinsate water was drained in the area where the samples were collected.

3.2 Sampling and Chemical Analyses and Methods

The following sections describe the sampling activities and chemical analyses for soil and water at OAL and Snake Butte. Additional detail on this work including SOPs are in the Phase II ESA Work Plan.

3.2.1 Old Agency Landfill

Figure 2 shows the inferred boundaries of the Old Agency Landfill based on site reconnaissance, exploratory test pit excavations, previous investigations, and interviews conducted during the Phase I ESA. Evidence of landfill waste uncovered by the test pits (Table 1) was used as the determining factor in selecting the locations of surface and subsurface soil samples collected for laboratory analysis of suspected contaminants. Soil samples were collected from within the landfill boundary, the outlying waste areas, and from beneath the rubble pile along the western boundary of the landfill (Figure 2). Sample methodologies and locations for soil and water are described below.

Surface Soil

A total of three surface soil grab samples were collected in undisturbed areas directly adjacent to test pit locations OAL-TP-4, OAL-TP-32 and OAL-TP- 33 (Figure 2). The sample locations were roughly equally spaced within the landfill boundary, and one of the surface samples was collected within the area of the tar-like substance on the ground surface. All samples were collected by first removing the uppermost 1 to 2 inch organic layer, then obtaining representative soil material within the next one to two inches in depth (i.e. sample interval between 2 and 4 inches below the land surface). The samples were obtained using a large stainless steel spoon and placed in glass jars. The soil sampling field forms that document sampling activity are in Appendix 1, copies of entries in the field logbook are in Appendix 2, and site photographs are in Appendix 3.

Sample designations and analytical parameters for the Old Agency Landfill are shown on Table 2 below. Specific sample handling requirements for soil samples and SOPs used for sample collection and handling are in the Phase II ESA Work Plan.

Subsurface Soil

A total of eight subsurface soil samples and one duplicate sample were collected from test pit locations OAL-TP-4, OAL-TP-9, OAL-TP-12, OAL-TP-23, OAL-TP-28, OAL-TP-30, OAL-TP-32, and OAL-TP-33 (Figure 2) and analyzed for the parameters in Table 2. The sample locations were based on indications of waste materials (used containers/debris, staining/odor) determined from observations of exploratory test pits. The sample interval was based on visual observations of changes in subsurface material characteristics.

The subsurface samples were collected using a backhoe by first excavating down to the base of landfill waste materials, collecting a sample of the native soil at the waste/native soil interface using the backhoe bucket, then obtaining a representative sample of the soil from the center of a backhoe bucket using a decontaminated disposable scoop. At some locations, it appeared that the waste/soil interface coincided with the water table, or that the water table was within the waste materials. At these locations, the soil sample was collected at, or slightly above, the water

Table 2. OAL Soil and Water Samples and Analytical Parameters.

Sample Location	Sampling Rationale	Sampling Location	Sample Method	Number of Samples	Analysis Code	Matrix
OAL-S1 through OAL-S3	Identify the presence of contaminants of concern in surface soil	Proportional to Landfill Area and Based on Test Pits	Grab	3	A, C	Soil
OAL-SS1 through OAL-SS9*	Identify the presence of contaminants of concern in subsurface soil	Discrete, Based on Test Pits	Grab	9*	A, B, C	Soil
OAL-SW1	Determine chemistry signature of surface water	Oxbow Pond	Grab	1	D, E	Surface Water
OAL-SW2	Determine chemistry signature of surface water	Water Treatment Settling Pond	Grab	1	D, E	Surface Water
OAL-SW3	Determine chemistry signature of surface water	Water Treatment Backwash Pond	Grab	1	D, E	Surface Water
OAL-SW4	Determine chemistry signature of surface water	Milk River	Grab	1	D, E	Surface Water
OAL-01	Determine chemistry signature of groundwater	Monitoring Well OAL-01	Grab	1	D, E	Ground water
OAL-02	Determine chemistry signature of groundwater	Monitoring Well OAL-02	Grab	1	D, E	Ground water
OAL-03	Determine chemistry signature of groundwater	Monitoring Well OAL-03	Grab	1	D, E	Ground water

Analytical Code:
A PCB, Pesticides
B VOCs
C semi-VOCs, metals including: Ag, Al, As, Ba, Cd, Cr, Cu, Hg, Ni, Pb, Se, Tl, V, Zn
D Al, Cu, Fe, Na, Cl, SO_4 (groundwater metal samples filtered)
E Field Measurements: specific conductance, pH, temperature, water elevation

* Subsurface samples included one duplicate sample

table. The soil sampling field forms that document sampling activity are in Appendix 1, copies of entries in the field logbook are in Appendix 2, and site photographs are in Appendix 3.

Soil material adhering to the backhoe bucket was first scraped off, and the backhoe bucket was washed with pressurized water between sampling locations using a portable tanker vehicle provided by FBIC. The rinsate water was then allowed to drain over the excavation before the final cover was replaced.

Surface Water and Groundwater

A total of three groundwater and four surface water samples were collected at OAL to establish the chemical signatures and probable hydrologic connection of on-site and adjacent waters. Groundwater samples were collected from existing on-site wells OAL-1, OAL-2 and OAL-3 using a peristaltic pump, and surface water samples were collected from the water treatment plant settling pond, water treatment plant backwash pond, the oxbow pond, and from the Milk River. The sampling locations are shown on Figure 2, and the sample designations and analytical parameters are shown in Table 2. The sample handling requirements and SOPs used for sample collection and handling are in the Phase II ESA Work Plan.

3.2.2 Snake Butte

Surface Soil

The Phase I ESA identified several locations of possible fuel, chemical and explosives storage sites. The locations of these sites are shown on Figure 3. These areas were inspected and, based on visual evidence of staining, a total of two surface soil samples were collected at location SB-4 (Figure 3) to determine the presence of contamination. This particular area appeared to be the location of a former above ground storage tank based on presence of two small concrete slabs and an obvious black staining adjacent to the slabs and along the roadway, approximately 50 feet from the slabs.

The samples were collected by first scraping away the upper one to two inches of compacted surface material using a decontaminated hand shovel. The sample was then obtained over the next one to two inch depth interval (i.e. sample depth between two to four inches beneath the land surface) using a decontaminated stainless steel spoon. The soil sample designations and analytical parameters for Snake Butte are in Table 3, and sample handling requirements for soil samples and SOPs used for sample collection and handling are in the Phase II ESA Work Plan.

Table 3. Table 3 Snake Butte Soil and Water Samples and Analytical Parameters.

Sample ID	Sampling Rationale	Sampling Location	Sample Method	Number of Samples	Analysis Code	Matrix
SB-S4A	Evaluate presence of hazardous substance from mining operations	Soil adjacent to concrete slabs near Maintenance Yard	Grab	1	A	Soil
SB-S4B	Evaluate presence of hazardous substance from mining operations	Soil along road below area of concrete slabs	Grab	1	A	Soil
SB-W1	Determine presence of contamination and chemistry signature of springs	Snake Butte Spring	Grab	1	A, B, C	Ground water
SB-W2	Determine presence of contamination and chemistry signature of springs	Snake Butte Spring	Grab	1	A, B, C	Ground water
SB-W3	Determine presence of contamination and chemistry signature of springs	Snake Butte Spring	Grab	1	A, B, C	Ground water

Analytical Code:

A VOC
B Fe, Mn, Ca, Mg, Na, Cl, SO_4, Alkalinity Forms, NO_3+NO_2 as N
C Field Measurements: specific conductance, pH, temperature, flow

Springs

Based on map review and hydrologic reconnaissance, a total of three water samples from local springs adjacent to Snake Butte were collected to determine the presence of mining-related contaminants (VOCs and nitrate), and for signature parameters to assess the potential interconnection between the springs. The spring locations are shown on Figure 3 and the water sample designations and analytical parameters are in Table 3.

3.3 Data Validation

Analytical data were validated according to procedures found in the Phase II ESA Work Plan. Four data validation reports were prepared to address data for:

- Volatile organic compounds (VOCs);
- Semivolatile organic compounds (SVOCs);
- Polychlorinated biphenyls (PCBs); and
- Inorganics.

Data validation reports are found in Appendix 4, preceding the laboratory analytical results. The following data limitations were noted in the data validation reports:

- All SVOA compounds associated with OAL-S3 have been qualified with a 'UJ' validation flag to denote that the data is non-detectable at the reported value, but the reported value is an estimate due to low surrogate recovery.
- Aluminum in samples OAL-01, OAL-03, OAL-SW1, OAL-SW3, and OAL-SW4 have been qualified with a 'J' validation flag to denote that the data is detectable at the reported value, but the reported value is an estimate due to low MS recovery.
- Aluminum in samples OAL-02 and OAL-SW2 have been qualified with a 'UJ' validation flag to denote that the data is non-detectable at the reported value, but the reported value is an estimate due to low MS recovery.
- Copper in samples OAL-01, OAL-02, OAL-03, OAL-SW2, OAL-SW3, and OAL-SW4 have been qualified with a 'J' validation flag to denote that the data is detectable at the reported value, but the reported value is an estimate due to low MS recovery.
- Copper in sample OAL-SW1 has been qualified with a 'UJ' validation flag to denote that the data is non-detectable at the reported value, but the reported value is an estimate due to low MS recovery.

4.0 EVALUATION AND PRESENTATION OF RESULTS

The information collected from the Phase II ESA was evaluated to determine the presence of contamination and to verify/modify the conceptual models of OAL and Snake Butte. The following sections describe the physical conditions at each site, the field and analytical results, and the distribution of contaminants based on the laboratory analyses.

4.1 Old Agency Landfill

4.1.1 Site Conditions

The information from the exploration test pits at OAL suggests that the majority of the landfill waste is in the area shown on Figure 2. Aside from the tar-like substance observed at the land surface near OAL-TP-4, there was no direct visual evidence of chemical contamination (e.g. leaking drums/containers) within the area examined. There was, however, clear evidence of landfill-type debris that included construction materials, scrap metal, and other household/commercial type waste. There also was scattered construction/demolition debris (primarily bricks) found west of the landfill waste boundary (west of road) shown on Figure 2. However, there was no evidence of landfill waste in test pits in this area.

Geologically, the subsurface appears to consist of two distinct materials. The first material, observed in the majority of the test pits, consists of a light to dark brown (sometimes with a greenish tint), silty-clay. Due to the presence of rounded cobbles in the several of the pits, this material is believed to be glacial till (Alverson, 1965). Although it is possible that the clayey material could represent overbank deposits of the Milk River, the lack of stratification of the cobbles is more consistent with till. This material typically showed small, isolated zones of iron staining (even when no landfill waste was encountered) that is often associated with the vertical movement of water in the vadose zone.

The second type of material found at OAL consists of light to dark brown, silty-clayey sand that is believed to be fill material that was deposited artificially during operation of the landfill. This material is generally lighter in color than the clayey till and was usually found overlying or in direct contact with landfill waste. Some of the fill material found within the landfill boundary may have originated from construction of the adjacent water treatment ponds.

The groundwater table beneath OAL varies in depth, ranging from approximately four feet beneath the surface along the northern boundary of the landfill adjacent to the oxbow pond, to approximately seven feet towards the southern end of the landfill near well OAL-02. The water level elevations from surface water features in the area of OAL and from the three on-site monitoring wells were used to evaluate the direction of groundwater flow based on hydraulic head. Figure 4 is a potentiometric map of OAL that suggests that the direction of groundwater flow beneath the landfill is to the northwest, toward the oxbow pond and Milk River, with apparent influence from the water treatment ponds. Figure 4 assumes a direct hydraulic connection between water in the west treatment plant pond and the underlying groundwater system based on the similarity in water elevation between the pond and groundwater in well OAL-02.

4.1.2 Analytical Data

Soil

The laboratory analytical data for metals in OAL surface and subsurface soil samples are shown in Table 4 and laboratory reports are in Appendix 4. For comparison purposes, Table 4 also includes EPA Region 9 Preliminary Remediation Goals (PRGs) for residential soils, EPA Soil Screening Levels, and the results of a background surface soil sample collected by Ecology and Environmental (1991) in the southeast corner of the landfill.

The soils data show that, with few exceptions, metals and arsenic values exceed background concentrations in surface and subsurface soils within the landfill waste boundaries. EPA Soil Screening Levels and/or PRGs also are exceeded for As, Ba, Cd, Cr, Ni, Ag, and Zn. It is uncertain whether other parameters (e.g. Hg and Se) are elevated since detections limits are above the background value. Nevertheless, it is evident that there are widespread soil impacts within the landfill boundary resulting in elevated metals and arsenic concentrations.

The laboratory analytical data for organic chemicals in OAL surface and subsurface soil samples are shown in Table 5. Table 5 also includes EPA Soil Screening Levels and PRGs for organic constituents that were detected in samples above laboratory limits. None of the soil samples show detectable concentrations of VOCs or PCBs. Subsurface soil sample OAL-SS4, collected in the area of Test Pit 4 (Figure 2) detected the only SVOC found in landfill area soil (Bis(2-ethylhexyl)phthalate), with a concentration that is below the EPA PRG value. This particular SVOC is typically used as a plasticizer in a variety of industrial, domestic and medical products.

The most pronounced organic compounds found within the landfill waste boundaries were the pesticides DDD, DDE and DDT. These were detected in all three surface samples (near Test Pits 4, 32 and 33 on Figure 2), and in subsurface soil samples OAL-SS3, OAL-SS4 and OAL-SS6 (near Test Pits 33, 4 and 28, respectively). The area of Test Pit 4 showed the highest concentrations of pesticides in both surface and subsurface soil, with subsurface soil values exceeding EPA PRG and Soil Screening Level limits. It is important to note that the laboratory also increased its detection limits by over an order of magnitude for pesticide compounds in sample OAL-SS4. Therefore, it is possible that other pesticides are present at that location. Although the area of Test Pit 4 appears to the “hot spot” for pesticide contamination at OAL, the detection of pesticides in other sample locations suggest that there is widespread distribution of these contaminants within the landfill boundary.

Water

A summary of area water chemistry is shown in Table 6 and laboratory reports are in Appendix 4. The water chemistry data from the three on-site wells indicates that the groundwater beneath OAL has apparently elevated values of specific conductivity, SO_4, and Na. Well OAL-03 also shows apparently elevated values of Al and Fe. Surface water from the oxbow pond and Milk River shows SO_4 and Na occur in similar proportions (2:1 ratio) as OAL groundwater, but are over an order of magnitude lower in concentration than the values found in the groundwater.

Table 6. Summary of OAL Water Chemistry.

Sample ID	Sampling Location	Water Elevation (ft local datum)	Field pH	Field Specific Conductance (μmhos/cm)	Cl	SO_4	Na	Al	Cu	Fe
OAL-SW1	Oxbow Pond	2287.71	8.6	912	28	281	169	0.2	<0.001	0.38
OAL-SW2	Water Treatment Settling (east) Pond	-	8.3	503	6	104	57	<0.1	0.041	0.26
OAL-SW3	Water Treatment Backwash (west) Pond	2290.23	7.8	705	11	230	102	0.4	0.020	0.28
OAL-SW4	Milk River	2284.2*	8.2	378	<4	68	37	1.5	0.010	1.27
OAL-01	Monitoring Well	2288.57	6.8	18,530	180	12,200	6,480	0.2	0.002	2.58
OAL-02	Monitoring Well	2290.01	7.0	16,340	235	10,400	5,470	<0.1	0.006	0.04
OAL-03	Monitoring Well	2287.87	5.5	13,130	52	8,130	3,150	1.1	0.004	10.5
W40**	~4 mi. NW of OAL	-	8.7	2,690	33	730	630	<0.03	0.010	1.2
W41**	~2.5 mi. NW of OAL	-	8.6	3,150	-	-	-	-	-	-
W43**	~3 mi. NE of OAL	-	7.5	4,200	120	1,300	840	<0.03	0.015	5.8

Units in mg/L unless otherwise noted
OAL samples collected and water elevations measured 9/26/02
* Measured 4/29/02
** Alluvial wells within 4-mile radius of OAL (Lawlor, 2000)

It is unclear whether the apparently elevated specific conductance, SO_4 and Na in groundwater beneath the landfill represent ambient conditions for that particular hydrostratigraphic unit, or if landfill wastes have impacted groundwater quality. It is interesting to note that the elevated concentrations of SO_4 and Na found in OAL groundwater are not reflected in water from the water treatment ponds. The Phase I investigation discovered that the edges of the ponds are sprayed with copper sulfate to minimize weed/algae growth, and that the treatment plant uses aluminum sulfate as a coagulant in the water treatment process. Although the difference in hydraulic head between the ponds and groundwater beneath the landfill (Figure 4) indicate that that the ponds likely contribute to groundwater recharge, the ponds show lower values of Al, Fe and SO_4 than groundwater. This shows that, at least at the time the samples were collected, there were no obvious signs of chemical additives in the ponds that could be responsible for the elevated values found in OAL groundwater. However, this does not mean that chemical additives could have been used earlier in the year, and could still be impacting groundwater quality due to a slow migration of water from the ponds to the monitoring wells.

As a rough comparison, Table 4 also shows water chemistry values for three alluvial wells within a four-mile radius of the landfill (Lawlor, 2000). Although completed in different strata, they are useful to provide an indication of groundwater quality within the Milk River Valley.

Feltis (1983) also shows that SO_4 and Na can reach concentrations up to 2,200 mg/L and 1,200 mg/L, respectively, in (shallow and deep) groundwater in the general vicinity of Fort Belknap Agency. Both of these upper limits are several times lower than those measured in OAL groundwater.

The elevated concentrations of constituents present in OAL groundwater could be derived from non-natural sources related to landfill wastes. This is demonstrated by the variability in pH and Fe and Al concentrations measured in groundwater from each of the three on-site wells. Since the wells are completed at approximately the same depth in essentially the same geologic materials, the variability observed in these parameters would not typically be expected. In the case of Fe, a difference from 0.04 mg/L in well OAL-02 to 10.5 mg/L in well OAL-03 over a relatively short distance (approximately 300 feet) suggests that there are localized areas of different water quality as a function of proximity to waste materials (Figure 2 and Table 1).

Based on Figure 4, all three OAL wells appear to be located in the downgradient groundwater flow path from landfill waste materials. Although located within the landfill waste boundary, well OAL-02 is upgradient of most of the waste materials. Well OAL-03 is in the most downgradient location from waste areas than the other wells, indicating that this well is in a location that could detect the greatest amount of impact to water quality from landfill leachate.

The relatively low concentrations of constituents in oxbow pond water compared to OAL groundwater (e.g. specific conductivity) is not unexpected. Although OAL groundwater discharges to the pond, the pond also receives contributions of groundwater from other upgradient sources beyond the landfill boundaries that dilute the constituents in OAL groundwater.

It also is important to note that the well logs for OAL-01 and OAL-03 show that the screened intervals extend from 14.5 to 18.5 feet beneath the land surface. When considering that that the water table depth is approximately six to seven feet below the land surface, the potential exists that groundwater sampled from the wells is not representative of the uppermost seven or eight feet of aquifer. This may have important ramifications when using these wells to properly characterize the true extent of impacts to groundwater quality at OAL.

4.2 Snake Butte

4.2.1 Site Conditions

The area of the former quarry site at Snake Butte (Figure 1) has been physically altered as a result of historic mining activities. However, other than the physical changes that have occurred at the site there is little evidence to suggest that the site is contaminated. With the exception of several small foundations, there are no buildings or ancillary facilities remaining at the site. The surface of the quarry area consists of crushed waste rock, boulder-sized waste rock and bedrock, with sparse vegetation characteristic of disturbed areas.

Based on a hydrologic reconnaissance of the area and review of available literature, groundwater occurs within fractured bedrock (shonkonite) beneath the surface of Snake Butte and former quarry area. From review of area topography and elevations of area springs, on a large-scale, groundwater likely flows radially from Snake Butte towards the north, east and southeast. Groundwater beneath the quarry site is assumed to flow generally to the north. On a smaller scale, groundwater flow direction may be influenced locally by the orthogonal joint sets and other fractures that occur in the shonkonite.

The underground tunnels that were created for blasting during quarry operations are not believed to be affecting the groundwater flow system. Elevation data for the underground tunnels indicated that the tunnels are between 100 and 200 feet higher in elevation than the springs in the quarry area. Also, the tunnels were used for placement of explosives, and there was no mention of water problems with blasting or the need to drain water from the tunnels in the literature. It is possible that the remnants of the tunnels could intercept and somehow alter precipitation recharge to the underlying groundwater system. However, given the small area of the quarry and tunnel system relative to the size of Snake Butte, any effect from the tunnels is likely to be very localized with little impact to the overall groundwater system in the area.

Three springs occur in the general vicinity of the former quarry site (Figure 3). Springs originate when the water table intersects the land surface. There are a number of geological conditions that can cause this to happen. Based on site reconnaissance, the springs in the quarry area are likely the result of a combination of the following: 1) the regional water table intersects an abrupt change in surface topography, usually at the base of hillsides or in localized depressions in land surface such as incised drainages (technically referred to as depression springs); 2) fractures within bedrock transmit groundwater under hydrostatic pressure to surface outcrops or into alluvial/colluvial material where it eventually appears at the land surface (referred to as fracture springs), and; 3) groundwater within colluvium/alluvium or fractured bedrock on hillsides and in drainages becomes perched on less permeable bedrock or other material (baked shale in the case of Snake Butte). Being unable to percolate downward into the underlying lower permeability material, groundwater travels downgradient along this contact until it finally breaks out at land surface where the depth to water becomes shallow (referred to as contact springs).

Spring SB-W1 (Drinking Water Spring)

The largest spring in the area of the quarry also provides a source of potable water to area residents. The spring is located northwest and adjacent to the quarry site and was developed by COE in association with the quarry operations. The developed spring consists of a collection gallery/cistern with an overflow pipe. Due to the close proximity to bedrock outcrops, the spring

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is likely to be either a fracture spring, contact spring, or a combination of the two, whereby groundwater within fractured shonkonite intersects the land surface. As part of the Phase II ESA, FBEPD personnel have been monitoring the flow rate at this spring. Their data show a range of 15 to 23 gallons per minute, with a noticeable increase in flow occurring in May and June (Bishop, personal communication, 2002), which is a typical for seasonal precipitation recharge. This change in flow rate suggests that the spring is recharged by local precipitation to Snake Butte, as opposed to being part of a deeper, regional groundwater system. The water from the springs appears to flow along the land surface for relatively short distance then infiltrates back into the ground.

Spring SB-W2 (Culvert Spring)

The second spring occurs between the central portion of the quarry and the road to the north. The site has been developed by placing a perforated, section of metal culvert pipe, approximate 24-inch wide, vertically into the underlying colluvial material to act as a cistern. The spring reportedly flows at the land surface during the spring-summer season. However, the spring was not flowing and the water level was several feet below the ground surface in the culvert at the time of the Phase II ESA sampling work during late September. The variation in flow conditions at the site indicates that, like SB-W1 to the west, the water table elevation in the vicinity of the spring rises and falls seasonally as a function of precipitation recharge. Given the close proximity of the spring to the quarry, the water in the spring probably originates from water-bearing fractures of Snake Butte that come into contact with the overlying colluvium that flanks the sides of the butte.

Spring SB-W3 (Buffalo Pasture Spring)

The third spring in the area is further distant (approximately 2,000 feet) from the quarry site than the first two springs. It is located in the buffalo pasture area on the east flank of Snake Butte. The spring occurs in colluvium and is either a depression or contact spring, with the source of water probably originating from the Snake Butte fractured bedrock system. The spring is located at the head of a small drainage feature and water from the springs appears to flow within the drainage then infiltrate back into the ground during high water table conditions. At the time of the sampling event in late September, however, there was only a large pool of water and no visible flow in the drainage. The spring is used extensively by the buffalo herd as a source of drinking water. Consequently, the site is heavily disturbed and was muddy at the time of the Phase II ESA inspection.

4.2.2 Analytical Data

Soil

Two surface soil samples (SB-S4A and SB-S4B) were collected from the vicinity of a suspected above ground tank (Site SB-4 on Figure 3). This particular site was selected for soil sampling because of a noticeable black staining within the upper few inches of soil in two separate areas in close proximity to each other. Suspecting the presence of petroleum hydrocarbons, soil samples were analyzed for VOCs. However, the laboratory results (Appendix 4) did not show any VOCs present above detectable concentrations in soil collected in these areas. This indicates that either the VOCs have volatilized to below laboratory detection since the time of the spill, or that the stain may contain other types of constituents such as SVOCs.

Water

Water quality data for the three area springs are shown on Table 7 and laboratory reports are in Appendix 4. The data show that there is some similarity in water chemistry between the three springs in that the concentrations of most constituents (e.g. specific conductance) are generally within the same order of magnitude. This would suggest that the springs are connected to the same regional groundwater system. However, there also are slight variations in specific parameters, indicating that the groundwater quality of each spring is influenced by local variations in mineralogy. Site SB-W1 shows Na as the dominant cation, and HCO_3 and SO_4 as the dominant anions. Site SB-W2 shows both Ca and Na as dominant cations, and HCO_3 as the dominant anion (over twice the value of SO_4). Site SB-W3 also shows Na and Ca as the dominant cations, but SO_4 is the dominant anion (twice the value of HCO_3). SB-W3 also shows a value of NO_3 plus NO_2 that is elevated above the concentrations in the other springs which may be explained, in part, by the heavy use of the site by the buffalo herd (buffalo manure was observed adjacent to the spring).

The high concentration of Fe at SB-W2 compared to the other two springs could imply that there is some impact from buried metal at the quarry site since that spring is relatively close to and downgradient of the quarry. However it also is possible that the water quality simply reflects area mineralogy, or that the presence of the iron culvert may be contributing to the elevated level of iron.

There also was a low-level (1 µg/l) detection of toluene from the Buffalo Pasture Spring. This concentration is well below regulatory action levels and was the only organic chemical detected at any of the spring sites. The source of this constituent is uncertain. This site is furthest away from the quarry and not in an obvious groundwater flow path from the quarry area. Given the absence of any other organic constituents indicative of petroleum hydrocarbon or solvents, the source of toluene is not believed to be due to any contamination from the quarry.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Old Agency Landfill

The analytical results of surface and subsurface soil samples at OAL indicate that there is detectable contamination within the landfill boundaries from metals, arsenic and organic chemicals associated with pesticides. There were no VOCs or PCBs detected in soils, and a SVOC was found in one soil sample.

Several of the metal constituents (As, Ba, Cd, Cr, Ni, Ag, and Zn) found in soils exceed EPA Soil Screening Levels and one (As) exceeds Region 9 PRGs in multiple samples (refer to Table 4). To estimate the metals toxicity characteristic in a solid for comparison to the Toxicity Characteristic Leaching Procedure (TCLP) regulatory levels (per Table 1, 40 CFR 261.24), the total analysis value is divided by 20. Only one metal (lead) detected in sample number OAL-SS4 (from location TP-4), at a concentration of 351 mg/kg, exceeded this criteria.

Detected values of arsenic ranged from 1.6 to 8.1 times greater than one background sample. The background sample had a reported arsenic concentration of 6.2 mg/kg. In twelve tests, the arsenic concentrations were between 10 mg/kg and 17 mg/kg for ten samples, 50 mg/kg for one sample, and less than 10 mg/kg for one sample. Although elevated from the background sample, these values are not high relative to naturally occurring arsenic concentrations found in many Montana soils.

Detectable levels of pesticides were found in three subsurface soils and three surface soils. The highest concentrations were found in subsurface soils approximately 30 feet from the oxbow pond. These were found approximately four feet below land surface at TP-4, which was excavated within an approximately 600 square feet area containing a tar-like substance on the surface. The reported pesticide concentrations exceed Region 9 PRGs by more than one order of magnitude. This suggests an increased risk of exposure in this area, and potential migration pathway from soils to sediments along the shore of the oxbow pond. Additional sediment samples collected along the shore of the oxbow pond in between Test Pits 4 and 33 and analyzed for pesticides would be needed to further characterize this area.

Analyses of groundwater samples collected from the monitoring wells indicate that the water quality beneath the landfill could be impacted from landfill wastes. Specific conductance, sulfate, Al, and Fe appear to be elevated above regional values. Previous groundwater sampling (Maxim, 2000) showed detectable levels of several metals and nitrate/nitrite below EPA MCLs; sulfate concentrations exceeding EPA MCLs; and slightly elevated chloride in well OAL-01 (below EPA MCLs). The Phase II ESA water samples were not analyzed for organic chemicals, since previous sampling by Maxim and FBEPD did not detect these types of constituents.

In contrast to the groundwater, the surface water sample collected from the oxbow pond did not show any impacts to water quality from the landfill. Based on the data from a limited number of surface water samples collected as part of this Phase II ESA and those analyzed in previous reports, there is no evidence indicating that water quality at the Fort Belknap Agency drinking water intake has been affected by the landfill.

Based on surface water and groundwater elevation data, and the detection of elevated inorganic constituents, it appears that existing monitoring wells OAL-01, OAL-02 and OAL-03 are located appropriately in the downgradient groundwater flow direction from waste materials. Since the wells appear to be properly located to enable detection of contaminants, it is uncertain why the organic contaminants detected in area soils were not detected in previous groundwater samples, especially the sample from well OAL-01 which is downgradient from the pesticide contamination near Test Pit 33. As suggested by Ecology and Environmental (1990), one reason for this could be that the clay in subsurface soil is attenuating the contaminants from landfill waste leachate. However, another possibility is that contaminants from the waste may be migrating as a thin plume within the upper few feet of the water table and above the screened interval of the wells. The well logs from OAL-01 and OAL-03 show that the screened intervals extend from 14.5 to 18.5 feet beneath the land surface. The depth to water level measured in the wells at the time of well construction and during the Phase II ESA sampling activity indicate that the water table is approximately six to seven feet below the land surface. In this case, the well completion design may preclude obtaining a fully representative sample of groundwater beneath OAL.

The Phase III work will develop an appropriate land use strategy for OAL. Phase III activities related to soils could include additional sampling or risk assessment. In particular, it is recommended that the area near TP-4 (containing a tarlike substance on the surface) should be further investigated prior to any future cleanup actions. Future (post-Phase III) work may include material removal and/or capping to prevent surface exposure to humans and biota.

For the groundwater portion of OAL, there is more uncertainty as to the potential threat to human health and the environment. Therefore, additional investigation may be warranted (possibly based on risk assessment) to confirm the presence or absence of pesticide contaminants in groundwater. To accomplish this, two to three shallow monitoring wells that are screened through the water table and located downgradient of Test Pits 4, 33 and 32 could be installed. The wells can be constructed using standard drilling equipment or push probe technology. The wells should penetrate the groundwater table elevation, extend to approximately 10 feet below ground surface, and be screened from approximately 5 to 10 feet to allow for groundwater fluctuations. Once completed and properly developed, groundwater samples can be collected and analyzed for the organic compounds found in soil samples.

5.2 Snake Butte

Two localized areas of soil staining and three springs in the vicinity of the Snake Butte quarry were sampled for potential VOC (petroleum hydrocarbons and solvents) contamination. The analytical results did not show any indication of VOC contamination, indicating there are no lasting impacts from these types of constituents from the quarry operations. If fuel oil had leaked onto the ground surface in these areas, there is no indication of VOC contaminants (e.g. benzene) remaining in the soil, or impacting area groundwater.

The preliminary conceptual model of the Snake Butte quarry suggested contaminant migration pathways from waste material to soils, and from soils to area groundwater. Possible exposure pathways were direct contact with waste, soils and groundwater and ingestion of soils and groundwater. Based on the data collected for this Phase II ESA investigation, there does not appear to be any migration pathway to groundwater or exposure pathway from contact with groundwater for VOC contaminants. Based on perceived risk to receptors, the areas of stained soil could be resampled and analyzed for other potential contaminants such as SVOCs.

However, given the age of the former quarry and stained area, the likelihood of detecting elevated concentrations of organic constituents is believed to be low.

Water samples from the springs also were analyzed for nitrate, a compound commonly found in blasting agents, and those results showed relatively low concentrations. One of the springs did show a detectable level of toluene (a constituent of gasoline). However, the location of the spring relative to the quarry and the lack of any other detectable organic compounds suggests that the source of toluene is not from the quarry.

Based on the Phase II ESA results, there does not appear to be any potential threat to humans or indigenous wildlife in the area from contaminants in waste, soil or groundwater. From earlier investigations (FBEPP, 1999) one of the more likely hazards at Snake Butte concerns the safety to humans and wildlife from the rock piles and high wall at the quarry. Any future work performed for Snake Butte should therefore consider a recontouring scheme for the area to promote safety and to better blend the site in with the surrounding, undisturbed topography.

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